Cambridge Assessment International Education

Cambridge International AS & A Level

PHYSICS **9702/21**

Paper 2 AS Level Structured Questions **October/November 2020**

MARK SCHEME

Maximum Mark: 60

Published

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge International will not enter into discussions about these mark schemes.

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[Turn over

Mark categories

B marks	These are independent marks, which do not depend on other marks. For a **B** mark to be awarded, the point to which it refers must be seen specifically in the candidate's answer.
M marks	These are method marks upon which **A** marks later depend. For an **M** mark to be awarded, the point to which it refers must be seen specifically in the candidate's answer. If a candidate is not awarded an **M** mark, then the later **A** mark cannot be awarded either.
C marks	These are compensatory marks which can be awarded even if the points to which they refer are not written down by the candidate, providing subsequent working gives evidence that they must have known them. For example, if an equation carries a **C** mark and the candidate does not write down the actual equation but does correct working which shows the candidate knew the equation, then the **C** mark is awarded. If a correct answer is given to a numerical question, all of the preceding **C** marks are awarded automatically. It is only necessary to consider each of the **C** marks in turn when the numerical answer is not correct.
A marks	These are answer marks. They may depend on an **M** mark or allow a **C** mark to be awarded by implication.

Annotations

✓	Indicates the point at which a mark has been awarded.
X	Indicates an incorrect answer or a point at which a decision is made not to award a mark.
XP	Indicates a physically incorrect equation ('incorrect physics'). No credit is given for substitution, or subsequent arithmetic, in a physically incorrect equation.
ECF	Indicates 'error carried forward'. Answers to later numerical questions can always be awarded up to full credit provided they are consistent with earlier incorrect answers. Within a section of a numerical question, ECF can be given after AE, TE and POT errors, but **not** after XP.
AE	Indicates an arithmetic error. Do not allow the mark where the error occurs. Then follow through the working/calculation giving full subsequent ECF if there are no further errors.
POT	Indicates a power of ten error. Do not allow the mark where the error occurs. Then follow through the working/calculation giving full subsequent ECF if there are no further errors.

TE	Indicates incorrect transcription of the correct data from the question, a graph, data sheet or a previous answer. For example, the value of 1.6×10^{-19} has been written down as 6.1×10^{-19} or 1.6×10^{19}. Do not allow the mark where the error occurs. Then follow through the working/calculation giving full subsequent ECF if there are no further errors.
SF	Indicates that the correct answer is seen in the working but the final answer is incorrect as it is expressed to too few significant figures.
BOD	Indicates that a mark is awarded where the candidate provides an answer that is not totally satisfactory, but the examiner feels that sufficient work has been done ('benefit of doubt').
CON	Indicates that a response is contradictory.
I	Indicates parts of a response that have been seen but disregarded as irrelevant.
M0	Indicates where an A category mark has not been awarded due to the M category mark upon which it depends not having previously been awarded.
^	Indicates where more is needed for a mark to be awarded (what is written is not wrong, but not enough). May also be used to annotate a response space that has been left completely blank.
SEEN	Indicates that a page has been seen.

Question	Answer	Marks
1(a)(i)	force × perpendicular distance (of line of action of force to the point)	**B1**
1(a)(ii)	units: kg m s^{-2} m = kg m^2 s^{-2}	**A1**
1(b)	$W = \rho Vg$ **or** $W = \rho ALg$	**C1**
	A = 5.2 / (790 × 2.4 × 9.81) (= 2.8×10^{-4} (m^2))	**C1**
	= 2.8×10^2 mm^2	**A1**
1(c)(i)	(component =) 5.2 sin 56° = 4.3 (N) **or** 5.2 cos 34° = 4.3 (N)	**A1**
1(c)(ii)	(T × 2.4) **or** (4.3 × 1.2) **or** (4.6 × 1.8)	**C1**
	(T × 2.4) + (4.3 × 1.2) = (4.6 × 1.8)	**C1**
	T = 1.3 N	**A1**

Question	Answer	Marks
2(a)	constant gradient	**B1**
2(b)	(displacement until 0.20 s =) ½ × 1.96 × 0.20 (= 0.196 m) **or** (displacement after 0.20 s =) ½ × 6.86 × 0.70 (= 2.401 m)	**C1**
	height = 2.401 – 0.196	**C1**
	= 2.2 m (*alternative methods are possible using equations of uniformly accelerated motion*)	**A1**
2(c)	(Δ)E = mg(Δ)h **or** W(Δ)h	**C1**
	(Δ)E = 0.86 × 2.2 = 1.9 J	**A1**
2(d)	curved line from the origin	**M1**
	gradient of curved line decreases and is zero at t = 0.20 s only	**A1**
2(e)	acceleration (of free fall) is unchanged/is not dependent on mass and (so) no effect	**B1**

Question	Answer	Marks
3(a)	(force =) rate of change of momentum	**B1**
3(b)(i)	$E = ½mv^2$ **or** $½ \times 0.062 \times 3.8^2$ **or** $½ \times 0.062 \times 1.7^2$	**C1**
	loss of KE $= ½ \times 0.062 \times (3.8^2 - 1.7^2)$ $= 0.36$ J	**A1**
3(b)(ii)	$p = mv$ **or** 0.062×3.8 **or** 0.062×1.7	**C1**
	change in momentum $= 0.062 \times (1.7 + 3.8)$ $= 0.34$ N s	**A1**
3(b)(iii)	(average resultant force =) $0.34 / 0.081 = 4.2$ (N) **or** (average resultant force =) $0.062 \times (1.7 + 3.8) / 0.081 = 4.2$ (N)	**A1**
3(b)(iv)	**1.** average force $= 4.2 + (0.062 \times 9.81)$ $= 4.8$ N	**A1**
	2. average force $= 4.8$ N	**A1**

Question	Answer	Marks
4(a)(i)	(stress =) force / cross-sectional area	**B1**
4(a)(ii)	(strain =) extension / original length	**B1**
4(b)(i)	$E = FL / Ax$	**C1**
	$= GL / A$	**A1**
4(b)(ii)	straight line from origin above the original line	**M1**
	line ends at point (4 small squares, F_1).	**A1**
4(b)(iii)	**1.** shaded area below the graph line and between the two vertical dashed lines	**B1**
	2. remove the force/F/F_2 and the wire goes back to original length/zero extension	**B1**
4(b)(iv)	values have a large range	**B1**

Question	Answer	Marks
5(a)	$v = \lambda / T$ **or** $v = f\lambda$ **and** $f = 1 / T$	**C1**
	$v = 8.0 \times 10^{-2} / 0.40$ $= 0.20\ \text{m s}^{-1}$	**A1**
5(b)	$I \propto A^2$	**C1**
	ratio $= 2^2 / 4^2$	**C1**
	$= 0.25$	**A1**

Question	Answer	Marks
6(a)	the waves (of the same type) move in opposite directions and overlap	**B1**
	the waves have the same (speed and) frequency/wavelength	**B1**
6(b)(i)	zero amplitude	**B1**
6(b)(ii)	distance $= 6.0 \times 4$ $= 24$ cm	**A1**
6(b)(iii)	180°	**A1**

Question	Answer	Marks
7(a)	volt / ampere	**B1**
7(b)	$R = \rho L / A$	**C1**
	$A = 460 \times 10^{-9} \times 2.5 / 3.2$	**C1**
	$= 3.6 \times 10^{-7}$ m^2	**A1**
7(c)(i)	energy is dissipated in the internal resistance/r	**B1**
7(c)(ii)	$E = IR + Ir$ **or** $E = I(R + r)$	**B1**
7(c)(iii)	$P = I^2R$ **or** $P = I^2r$	**C1**
	$I = E / 2r$ (so) $P = E^2 / 4r$	**A1**

Question	Answer	Marks
8(a)	similarity: same/equal mass **or** same/equal (magnitude of) charge **or** both fundamental (particles)	**B1**
	difference: opposite (sign of) charge **or** one is matter and the other is antimatter	**B1**
8(b)(i)	number of protons = 13 **and** number of neutrons = 12	**A1**
8(b)(ii)	(charge =) $13 \times 1.60 \times 10^{-19}$ (C) = 2.1×10^{-18} (C)	**A1**
8(c)	force = $11 \times 10^{3} \times 2.1 \times 10^{-18}$	**C1**
	work done = $11 \times 10^{3} \times 2.1 \times 10^{-18} \times 0.04$	**C1**
	= 9.2×10^{-16} J	**A1**